Australian Government

Department of Climate Change, Energy, the Environment and Water

National Climate Scenario Guidance

Cataloguing data

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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past and present.

Contents

Introduction

Australians are already experiencing the impacts of climate change – from longer fire seasons and intense heatwaves, to more extreme rainfall and coastal erosion (Australian Climate Service 2025).

Our climate will continue to change as the world warms, creating greater risks for Australian businesses, governments, communities and households. These risks are systemic – affecting not only our immediate assets but the services, infrastructure and supply chains we depend on. Moreover, different kinds of climate impacts can have a compounding effect on one another, increasing the overall impact (IPCC 2022).

To plan for the future, we need to understand these escalating risks and how they will affect us. Under mandatory climate-related disclosures, many Australian companies are now required to identify and assess the risks and opportunities they face due to climate change. Many other organisations and individuals, including local governments, planners, engineers, and service providers also need to undertake climate risk assessments, develop adaptation plans, and/or consider climate change when planning future development.

Our climate will continue to change and risks to society will increase. The extent of these changes depends on how quickly the world reduces greenhouse gas emissions. Even with today's advanced climate models, any projection of our climate future involves some level of uncertainty due to societal choices that control emission trajectories and natural climate variability. Considering a range of possible outcomes will help manage this complexity.

This is where climate scenarios come in. Climate scenario analysis is a tool for exploring how climate change and evolving policies and technologies could potentially impact businesses, communities, investments, and other systems or entities. It involves developing one or more plausible pictures of the future climate using available models and data.

Users have varying needs when it comes to climate scenario analysis. For example, reporting entities under the Australian Accounting Standards Board Standard 2 (AASB S2) climate-related disclosure regime are required to base their assessments on at least 2 climate scenarios to consider various possible futures and the impacts associated with each. On the other hand, critical infrastructure planners may choose to consider a high-emissions pathway, to ensure they are designing for the worst-case scenario and protecting essential services.

When beginning a climate scenario analysis, users are faced with choices such as which emissions pathways and datasets to use, what timeframes to consider and which climate hazards and indices to assess. This can make the process complex and daunting. The array of choices may also lead to misalignment and inconsistency, making it hard to compare one analysis to another.

> Reporting requirements under Australia's new mandatory climate-related disclosure regime started to be phased in from 1 January 2025. Start dates are staggered, based on the entity's size. For further details on the reporting regime, visit Regulatory resources sustainability reporting.

Purpose

This guide is intended to clarify the process of climate scenario analysis. It aims to ensure governments, businesses and engineers have the information they need to support comparable and consistent climate-related disclosure reporting, climate risk management and design of long-term infrastructure. It introduces key concepts and recommends appropriate approaches for different purposes.

Target audience

Parts 1 and 2 of this guidance are primarily aimed at supporting small and medium sized businesses, local governments, and other groups who are new to climate scenario analysis or have a basic level of understanding.

Part 3 is aimed at more advanced users seeking guidance on which climate models and datasets to choose.

How to use this guide

New to climate scenario analysis?

YES Read Part 1 first

- **PART 1** introduces core concepts and resources that anyone conducting climate scenario analysis should be familiar with.

These include:

- the different emissions pathways developed by the Intergovernmental Panel on Climate Change (IPCC) and how they relate to each other and to different levels of warming
- key parameters we need to consider, including baselines, time horizons and spatial scales.

This introductory section also includes basic guidance on using climate data, including working with probabilities, averages and ranges, as well as providing some basic information on the risks for different sectors.

NO You may wish to jump to Part 2

- **PART 2** provides a decision framework designed to help users identify the specific goals and scope of their analysis, and what kinds of pathways and supporting data best suit their purpose.

- **PART 3** provides information on high-resolution climate projections available in Australia.

ADVANCED users can use these datasets to develop their own scenarios.

Part 1: Foundations

1.1 Climate scenarios explained

Climate scenarios are descriptions of possible futures that provide insight into how future societal changes, such as evolution of technology, economic growth and greenhouse gas emissions, may affect goals and objectives of an organisation.

They should be plausible, distinctive, consistent, relevant and challenging (TCFD, 2017).

While our climate will continue to change and risks to society will increase, the timing and magnitude of these changes depends on how quickly the world reduces greenhouse gas emissions. Moreover, any projection of our future climate involves some level of uncertainty due to potential future emissions pathways, natural climate variability and model uncertainty. One way to assess the impacts of climate change is through scenario analysis (NESP ESCC, 2020).

Scenarios are descriptions of possible futures. They are not predictions or forecasts, because the outcomes depend on a range of assumptions, such as future technology, economic growth and greenhouse gas emissions.

The term 'scenario' appears a lot in climate science and climate risk assessment. It has different meanings in different contexts, which can be confusing. In this guidance, we use the Intergovernmental Panel on Climate Change's (IPCC) definition of a 'scenario' as a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g. rate of technological change, prices) and relationships.

Climate scenario analysis

Climate scenario analysis is a method for exploring how climate change and evolving policies and technologies could impact businesses, communities, investments, and other systems or entities. The analysis involves developing one or more plausible pictures of future climate using available models and data. Climate scenario analysis is an approach that can be used to test the resilience of business models in a changing climate.

In this guide, we are concerned specifically with the impacts of future physical climate risks. That is, risks resulting from climatic events such as bushfires, storms and floods, including acute, chronic and slow onset events. Many businesses and organisations – including reporting entities under the new regime of climate-related disclosures – will also wish to understand their transition risks and opportunities (see Box 1).

Box 1: Resources for understanding transition risks

Transition risks and opportunities arise from Australia and the world's efforts to reduce greenhouse gas emissions, including policy, legal, technological, market and reputational risks. Transition risks are not covered in this guide; however, we do note that changes in physical hazards will likely affect the transition.

Additional resources to assess transition risk:

1. General and sector-specific trends relevant for transition risks are available from the IPCC Sixth Assessment Report Working Group 3: Mitigation of Climate Change [PDF 3 MB]. Chapters include detail on emissions trends and drivers, and sector-specific chapters include energy, transport, industry, technology, buildings, agriculture, with some cross-sectoral perspectives also available in Chapter 12.
2. To understand potential scenarios for Australia's economy, environment and society, check out the Australian National Outlook.
3. The Network for Greening the Financial System's (NGFS) short-term scenario and long-term scenario tools are commonly used by financial sector entities.
4. The International Energy Agency (IEA) scenarios are often used by the resources and industrial sector.
5. The Climate Change Authorities Sector Pathways reports provide sector-specific details on what the net zero transition entails.
6. ClimateWorks Decarbonisation Futures seminal report shows how technologies in each sector can achieve climate goals in Australia when rebuilding the economy.
7. Reputex's Powering Australia Plan report on the economic impacts of the Powering Australia Plan.

1.2 Emission pathways

Emission pathways are modelled trajectories of global anthropogenic emissions (IPCC, 2023).

Shared Socioeconomic Pathways (SSPs) describe possible future development pathways in terms of factors that drive fossil fuel use and the global energy transition.

Representative Concentration Pathways (RCPs) describe possible trajectories for global greenhouse gas emissions by 2100.

People often relate more easily to global warming levels (GWLs), such as 'well below 2 °C', than to terms like SSPs or RCPs. To make scenarios more understandable for non-experts, base them on global warming levels. However, since data often uses SSPs, it's important to know how these link to different global warming levels and timeframes (Table 1).

SSPs provide a more comprehensive understanding of possible futures than GWLs as they include socioeconomic factors. SSPs are more appropriate for decisions that are time-dependent.

To explore the plausible range of climate futures, we recommend considering both a low-emissions (SSP1-2.6) and high-emissions (SSP3-7.0) pathway.

Most projections of our future climate and associated risks and impacts are based on emission pathways developed for the IPCC through the Coupled Model Intercomparison Project (CMIP). Before selecting any modelled data for their own scenario development and analysis, users need to understand these underlying pathways, including how they are defined and the key differences between them.

In its Fifth Assessment Report (2013), the IPCC used a set of **Representative Concentration Pathways (RCPs)** to represent different possible trajectories for global greenhouse gas emissions. Each RCP has a number, corresponding to the amount of radiative forcing expected by 2100, measured in watts per square metre – or, in simpler terms, the amount of excess heat energy trapped in the atmosphere due to greenhouse gas emissions, leading to global warming.

In its Sixth Assessment Report (2021), these RCPs were complemented by a set of **Shared Socio-economic Pathways (SSPs)**. SSPs are qualitative scenarios that explore possible future development pathways, particularly in terms of the factors driving fossil fuel use and the global energy transition. They explore a range of ways in which economics, demographics, policy choices, geopolitics and technological progress could influence greenhouse gas emissions and climate change.

Most people can relate more easily to a given level of global warming, such as 'well below 2 °C', than they can to a figure for radiative forcing, which defines the RCPs, or the detailed narratives of possible future development in the SSPs. Therefore, when building scenarios that are easier for a less technical audience to understand, consider basing them on global warming levels. Global warming levels describe what Australia may look like at a particular warming level, even if that level occurs earlier or later than projected – so they're not dependent on a particular year in the future. However, since the modelled data that underpins climate scenarios will often be expressed in SSPs, you'll need to understand how these align to different global warming levels, and the timeframes involved.

For a more detailed look at RCPs, SSPs and global warming levels, refer to Appendix A.

Table 1 shows the SSPs and global warming levels we recommend for use in climate scenario relative to other sources of climate scenarios. For a detailed comparison of emissions pathways, refer to the National Environmental Science Program (NESP) factsheet Understanding SSPs [PDF 185 KB].

Table 1: Comparison of emissions pathways, global warming levels (GWLs) and other scenarios

Emissions pathway	Recommendation	Shared Socio-economic Pathway (SSP) IPCC AR6 GWL by 2090 relative to 1850–1900* median [very likely range]	Representative Concentration Pathway (RCP) IPCC AR5 GWL by 2090 relative to 1850–1900* median [very likely range]	National Climate Risk Assessment (NCRA) Global Warming Level*	Mandatory climate-related disclosures – Australian Accounting Standards Board Sustainability Reporting Standard (AASB S2)	Network for Greening the Financial System (NGFS) scenarios (GWL at 2060)
Low emissions	Not recommended (unlikely with current policies)	SSP1-1.9 1.4 °C [1.0-1.8 °C]	RCP1.9	1.2 °C current		Low demand (1.1 °C) Net-zero 2050 (1.4 °C)
	Recommended (Aligned with current Paris Agreement goals)	**SSP1-2.6** **1.8 °C** **[1.3-2.4 °C]†**	**RCP2.6** 1.6 °C [0.9-2.3 °C]	**1.5 °C** at ~2030 **2.0 °C** at ~2050-2090	SSP1-2.6 could align with limiting global average temperature to 1.5 °C in best case scenarios	Delayed transition (1.7 °C) Below 2 °C (1.8 °C)
Intermediate emissions	Recommended (aligned with current global policy pledges)**	SSP2-4.5 2.7 °C [2.1-3.5 °C]	RCP4.5 2.4 °C [1.7-3.2 °C]			Nationally Determined Contributions (2.3 °C) Fragmented world (2.4 °C)

High emissions	**Recommended** for stress testing	**SSP3-7.0** **3.6 °C [2.8-4.6°C]**	No RCP equivalent	**3 °C** at ~2050-2090	SSP3-7.0 aligns with global average temperature exceeding 2 °C	Current Policies (3 °C)
	Not recommended (unlikely but is sometimes considered for a worst-case scenario)	SSP5-8.5 4.4 °C [3.3-5. 7 °C]	RCP8.5 4.3 °C [3.2-5.4 °C]			

*****Pre-industrial period (1850–1900), see next section for explanation of baselines.
**Be cautious that not all Australian datasets include all emissions pathways.

^Global warming levels are the average of surface temperatures over land and sea. Australian land surface temperatures have already warmed by 1.5 °C relative to the pre-industrial baseline.
†Warming of 1.5 °C is included within the 'very likely' temperature range for SSP1-2.6, meaning this scenario can be considered 'Paris compliant' and should satisfy the requirement under the Corporations Act for reporting entities to use a scenario that sees the global average temperature limited to that mentioned in 3(a)(ii) of the *Climate Change Act 2022*. See Appendix A for further details.

1.3 Other considerations when choosing and using climate scenarios

Decide which timeframe(s) to use

> To understand climate risks, users need to consider the timeframes over which changes are expected to occur.
>
> Most climate scenario analyses include 2 or more timeframes to understand how risks may vary over time. The most important timeframe(s) will depend on the purpose and scope of your analysis; however, to aid comparability with other analyses, we recommend using the same timeframes as National Climate Risk Assessment (see Table 2).

To understand climate risks, users need to consider the timeframes over which changes are expected to occur.

Most climate scenario analyses include 2 or more timeframes to understand how risks may vary over time. The most relevant timeframe will depend on your specific purpose and timings. For example, if a project or investment has only a short lifespan, such as a 3-year insurance policy or a road resurfacing that is expected to be replaced again in 10 years, you will be most concerned with climate risks within that near timeframe. However, if you are building a new bridge or assessing the long-term viability of your canola farm, you will need to be looking at projected climate risks over a much longer timescale. Ensure that the time it takes to *action* a decision is included in the overall time frame of interest.

Datasets typically provide information for different timeframes. Most commonly, the data will be provided for key years, such as 2050, based on a 20-year average period. For example, the data provided for 2050 will be an average of many climate models for a chosen IPCC emissions pathway from 2041 to 2060 to account for short-term fluctuations.

While the most important timeframe(s) will depend on the purpose and scope of your analysis, we recommend drawing from the set of timeframes presented in Table 2. These align with Australia's National Climate Risk Assessment. Sticking with these timeframes will facilitate comparison between scenario analyses conducted by different parties. Please note that while 2030 is not far into the future, the projections for 2030 are not forecasts. Also, note for coastal planning – you will need to consider timeframes beyond 2090 (see Box 3). To help you select a suitable timeframe for your analysis, see the decision framework in Part 2.

Table 2: Commonly used timeframes aligned with the National Climate Risk Assessment

Historical baseline*	Current climate**	Short-term	Medium-term	Long-term
(1850–1900)	**2020**	**2030**	**2050**	**2090**
	(2011–2030)	(2021–2040)	(2041–2060)	(2081–2100)

*This is the period chosen to be representative of the pre-industrial climate.
*In Australia's National Climate Risk Assessment, the current climate or 'present day' is represented by a combination of historical and projections. This approach is becoming increasingly common in climate change attribution studies. The main advantages of using historical and projected model data to define the current climate risk baseline is that it is directly comparable to the future climate and will include physical realisations of hazards that are a current risk but may not have occurred in the recent observational record (Lewis and Karoly, 2013). For example, a Category 4 tropical cyclone passing directly over Darwin (such as Cyclone Tracy in 1974) is a very real current climate hazard risk – but it would not be sampled if only observations of the past 30 years were used. The IPCC's Sixth Assessment Report typically represents it by the decade 2011–2020.

Decide which baseline to use

The baseline is the reference period or starting point to which we compare future changes.

The chosen baseline depends on the purpose of the analysis, comparability with other studies and alignment with specific standards or targets.

Ensure your baseline is clearly established and check others when comparing analyses.

Different climate observations and modelled climate data are often presented relative to different baselines. This is a normal and expected part of climate science. The chosen baseline depends on the purpose of the analysis, comparability with other studies and alignment with specific standards or targets. It's essential that users acknowledge when they are comparing figures from different baselines and take these differences into consideration.

The NCRA uses a current baseline of 20 years centred around 2020 (2011–2030). The 2020 baseline was chosen as it is representative of the present-day or recent average climate, characterises the sensitivity of the exposure unit to the present-day climate, and can be used to measure change (impact, mitigation and adaptation).

Another commonly used current baseline period, defined by the World Meteorological Organization (WMO) is 1961–1990. The IPCC uses the reference period 1850–1900 – a proxy for the 'pre-industrial' period, or the time before significant human interference in the climate system began. The Paris Agreement's temperature goal is relative to this pre-industrial baseline as are other references to Global Warming Level.

Always clearly establish your baseline and check others when comparing analyses – take any baseline differences into consideration for accurate comparisons.

Choose between the average and the range

The average (or – depending on how things are expressed – the mean, median or best estimate) provides a central estimate of the outcome.

The range captures the spread of possibilities in the projection, resulting from variation between results from different models and the natural climate variability captured in different model runs.

We advise against limiting your analysis to averages or best-estimate outcomes. Rather, we suggest considering ranges to explore a spectrum of possible future climate conditions. The range will capture more uncertainty, likely provide a better estimate of risk, and act as a stress test against more extreme scenarios.

Averages are appropriate when you want to understand the central tendency or most likely outcome for a given variable, such as increase in average temperature, change in average rainfall, or average recurrence interval for a given event. This may be useful for an initial assessment of potential climate risks.

Modelled climate data is typically represented as both an average and a range.

The average (or – depending on how things are expressed – the mean, median or best estimate) provides a central estimate of the outcome. The range captures the spread of possibilities in the projection, resulting from variation between results from different models and the natural climate variability captured in different model runs.

Confidence in a climate projection is a measure of how plausible the projected range of change is for a given emissions pathway. The degree of certainty (confidence) is determined by the amount of evidence and agreement of that evidence. If both the evidence and agreement are medium or high, a likelihood scale can be applied. This considers agreement with past trends, and the degree to which the physics is understood and expresses a probabilistic estimate of the occurrence of an event or outcome. For example, the outcome may be assessed as 'very likely' to be within a particular range. We can see examples of averages and ranges in Table 1. Under a low emissions pathway (SSP1-2.6), the best estimate is that the world will warm 1.8 °C by 2090 (relative to 1850–1900), and that the outcome is very likely (>90% probability) to be in the range of 1.3 – 2.4 °C.

You may also see the terms 'ensemble mean' or 'ensemble spread' used to describe averages and ranges. The ensemble mean is the average of all the models or model runs used. The ensemble spread is the range of variability *between* models or model runs used.

One of the many choices users face in scenario analysis is whether to use averages, ranges, or the results of individual model simulations. The right choice depends on our purpose and context. Averages, such as the ensemble mean, are appropriate when you want to understand the central tendency or most likely outcome for a given variable, such as increase in average temperature, change in average rainfall, or average recurrence interval for a given event. This may be useful for an initial assessment of potential climate risks. It should be noted that using averages without context can provide a false sense of precision as they will mask variation and distribution within the data.

To capture more uncertainty in your analysis we recommend considering the range. The range will likely provide a better estimate of risk, and stress test against more extreme scenarios (see Box 2). To assess the full range of modelled uncertainty, you will need to consider individual model simulations as plausible possible futures, including those that are significantly hotter, cooler, drier or wetter than the rest of the model ensemble.

Box 2: Accounting for climate extremes

To understand the impacts of climate change it is prudent to also examine the increased risks from extreme events, and not just the gradual shift in average conditions.

A small increase in average temperatures leads to a significant increase in the number of extreme and record hot days (see Figure 1). When it comes to rainfall, we may only see a modest change in annual rainfall, but find that more of that rain is coming in the form of short, intense downpours, increasing the risk of flash flooding.* As our climate changes, we will see more events that are outside our previous experience – such as the unprecedented 'Black Summer' fires o 2019–2020 and the east coast floods c 2022.

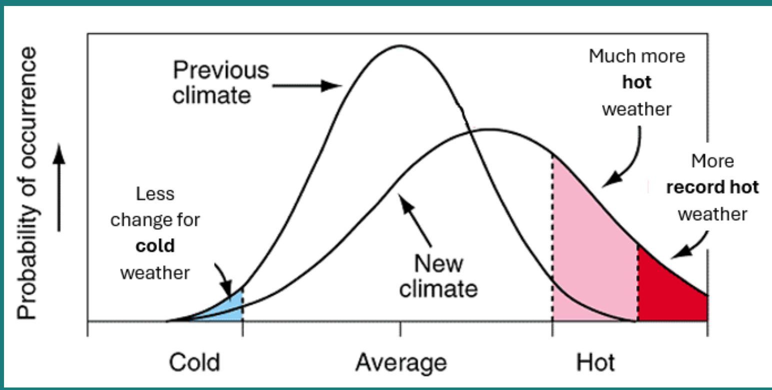


Figure 1: The effect on extreme temperatures when both the mean and variance increase for a normal distribution of temperature. Source: Modified from Figure 2.32c in IPCC, 2001.

The severe impacts of climate change are increasingly experienced with the rise of extreme events, such as dangerous heatwaves, unprecedented fire seasons, or destructive downpours.

Therefore, it's essential to consider extreme events in climate scenario analysis. Considering the upper and lower of the range of a metric can help (e.g. Figure 1). Given the limited state of knowledge, the "storyline" approach – linking past, current and future unfolding of events in a narrative or pathway framework – is particularly useful.

Accurately projecting the likely incidence and intensity of high-impact events has traditionally been a major challenge for climate modellers. However, as explored in Box 4, today's higher-resolution, convection-permitting models provide a better picture than before.

For more information see Dangerous climate tipping points will affect Australia. The risks are real and cannot be ignored - CSIRO.

*Observations show an increase in the intensity of short-term rainfall events in Australia, bringing increased risk of flash flooding. It is projected that Australians will see more intense short-duration heavy rainfall events, even in regions where the average rainfall decreases or stays the same. (CSIRO and BoM 2024.)

Spatial scale and spatial resolution

Spatial scale and spatial resolution are 2 important concepts in the development and application of climate scenarios and risks assessments.

Scale refers to the size or extent of the area being studied or modelled, such as global, national, regional or local. Resolution refers to the level of detail in the data, defined as the size of the grid cells, or the distance between data points.

Choosing the right scale and resolution depends on the scope and purpose of your analysis. For example, agricultural bodies may be interested in national or regional-scale changes in crop growing conditions and require data at a relatively low resolution. Local councils may wish to explore the likelihood of extreme rainfall events within their local catchment, requiring data over a smaller geographical region but at much higher resolution.

Further information on different datasets available in Australia, including an outline of their scale and resolution are outlined in Part 3.

1.4 Conducting scenario analysis

Scenario analysis is an important tool within the larger process of climate change risk assessment and adaptation planning.

Figure 2 describes a basic process of climate risk assessment, and how scenario analysis fits within this process.

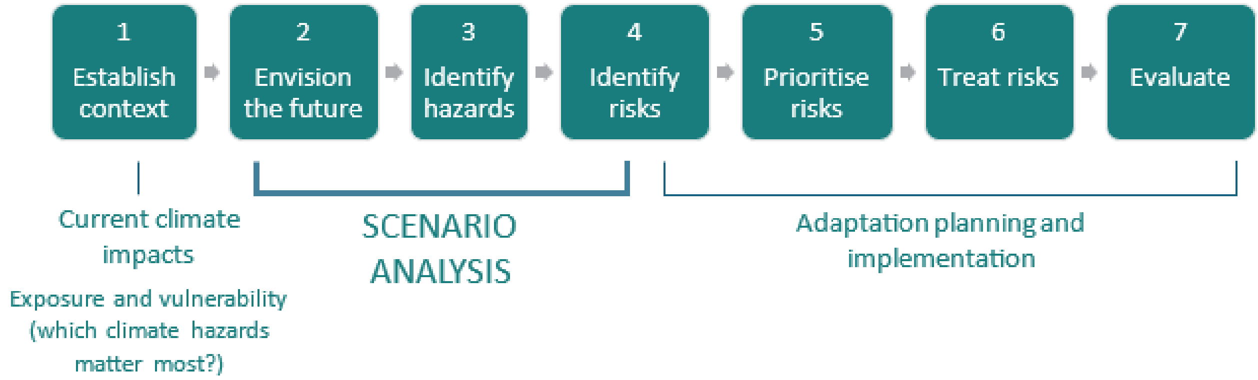


Figure 2: Scenario analysis within a basic process of climate change risk assessment and adaptation planning

Establish context

Before building scenarios, you should establish your context and consider the values and aspirations of your organisation, region or community. Why do you hold these values? What decisions will you need to make in the coming years and decades? These decisions and aspirations may be related to health, livelihood, economic development, education, food security, trade, biodiversity, heritage or many other values. Understanding the values of your organisation will help determine your needs for the future and risk tolerance, and hence your choice of scenario. If your risk tolerance is very low, you will want a scenario that tests risks to your organisation under extreme climate conditions. Even if your risk tolerance is high, it's still useful to understand the potential impacts associated with the higher emissions scenarios to inform cost benefits analyses. We recommend avoiding basing scenarios selection solely on minimising upfront cost.

You should also take stock of current climate impacts your organisation is exposed or vulnerable to as this will help to understand the situation you are starting from and what aspects of future climate risk you need to assess. Understanding the impacts most relevant to you – what type, at what scale, and over what timeframe – will determine the kind of information to build into your scenarios. To inform this exercise, it may be useful to consider how your organisation, region or community has been affected by past climate extremes (noting that such events may become more severe and frequent in the future). It is also important to consider how your organisation, region or community relies on other organisations, regions and communities, that may themselves be impacted by climate change.

Scenario analysis – Envision the future

Most users will want to have more than one scenario to compare the outcomes under different plausible climate futures; the number and type of pathways you choose should depend on the purpose, timing and scope of your analysis. See the decision framework in Part 2 of this guide to help you choose a suitable pathway and timeframe for your analysis.

We suggest starting with qualitative scenarios. These can be a useful starting point to explore the potential range of risks an organisation, region or community may face. Depending on your needs, you should consider following up with some level of quantitative scenario analysis that may incorporate impacts of the change in frequency or intensity of relevant physical hazards on economic or other aspects of your organisation, region or community.

Scenario analysis – Identify hazards

Climate scenarios and associated physical hazard information are the first steps in understanding and quantifying physical climate risks. For businesses, this will vary depending on the sector you operate within (see Table 3).

Climate hazards for different sectors

Difference sectors will face different types and combinations of physical climate risks. In building your scenarios, whether for a business, community or industry, you will need to identify the hazards that matter most to your situation.

While detailed sector specific guidance is beyond the scope of this guide, Table 3 offers a helpful starting point. It lists a sample of sectors, the types of hazards that are likely to be relevant to them, the kinds of data and information used to explore those hazards, and some useful metrics that could be used to assess their impact.

Note that this table is illustrative, not exhaustive and just provides examples. More detailed and technical scenario analysis will require specialist guidance. Only some of the data will be available in gridded (spatial) datasets, meaning most analyses will require a combination of qualitative and quantitative measures.

Table 3: Climate hazards for different sectors

Sector	Key physical climate hazards	Example(s) of possible impact	Example hazard metrics	Example exposure and vulnerability metrics for further assessment
Agriculture	• Drought • Heatwaves • Flooding • Bushfire	• Crop and/or livestock losses from floods • Prolonged drought reducing yields	• Projected temperature (mean, maximum and minimum daily, 1-in-20-year hottest day*) • Projected time in drought • Projected rainfall (average, seasonal, 1-in-100-year daily rainfall)	• Expected crop yield per hectare • Percentage of assets in high-risk zones • Loss ratios from extreme weather events
Real estate and construction	• Flooding • Storms • Heatwaves • Bushfires • Sea-level rise • Wind	• Urban flooding damaging buildings and roads • Devaluation in high-risk areas	• Projected rainfall (1-in-100-year daily rainfall) • Recent significant floods • Projected storm frequency and intensity • Sea-level allowance^ • Projected temperature (mean, maximum and minimum daily, 1-in-20-year hottest day) • Projected Forest Fire Danger Index (FFDI)	• Percentage of properties in flood-prone areas • Repair costs • Impact on insurance premiums
Manufacturing	• Flooding • Storms • Heatwaves	• Physical damage to facilities • Supply chain disruption	• Projected rainfall (1-in-100-year daily rainfall) • Recent significant floods • Projected storm frequency and intensity • Projected temperature (1-in-20-year hottest day)	• Percentage of facilities in high-risk areas • Supply chain downtime • Days of business interruption

Financial services	• Drought • Flooding • Storms • Heatwaves • Bushfires • Sea-level rise	• Asset devaluation from physical impacts • Business interruption	• Historic loss data • Recent significant extreme weather events • Projections for multiple hazard types (floods, storms, heatwaves, etc.)	• Loan portfolio exposure by hazard type • Scenario-based loss projections
Transport and logistics	• Flooding • Storms • Extreme heat • Sea-level rise	• Damage to roads, rails, ports and other infrastructure causing disruption of services	• Projected rainfall • (1-in-100-year daily rainfall) • Recent significant floods • Projected storm frequency and intensity • Projected temperature (1-in-20-year hottest day) • Sea-level allowance	• Percentage of infrastructure in high-risk areas • Disruption hours • Repair costs
Water security	• Drought • Changes in cool season rainfall • Extreme events	• Water quality • Water supply	• Multi-year dry • Evaporation • Runoff	• Number of towns with insufficient potable water to meet critical human needs

*1-in-20-year refers to an event that can be expected to occur, on average, once every 20 years (or, in other words, has a 5% probability of occurring in any given year).
^Sea-level allowance is the height that structure would need to be raised in future in order for the expected number of times the sea level exceeds that height to remain the same as today. (Note that a sea-level allowance is set against a present-day baseline rather than the pre-industrial baseline commonly used for temperature increases. This is in order to facilitate comparison with current coastal conditions, and because direct, high-quality measurements of sea level are not available for the more distant past.)

Scenario analysis – Identify risks

Risk assessment will require consideration of exposure and vulnerability to the various hazards identified using this guidance – both to your own assets and the supply chains, services and other systems and entities upon which you depend.

Further guidance on how to undertake a climate risk assessment, including physical and transition risks (Box 1), and sourcing exposure and vulnerability data is available from Climate Risk and Opportunity Management Program.

Transparency and replicability

Being clear and transparent about your assumptions and analytical choices is essential to credible and effective scenario analysis.

Transparency allows others to assess the robustness of your analysis and replicate or challenge the findings if necessary. It helps to build trust and credibility with your stakeholders. For reporting entities under the new climate-related disclosure regime, it is essential to meeting regulatory requirements. Lastly, it enables meaningful comparisons of the risks faced by different organisations and the strength of their resilience measures.

In presenting your analysis, you should make sure to include at a minimum:

- the basic parameters you have used, including timeframes, baseline for comparison and the regions you have considered
- your choice of scenarios and datasets, including the specific models you chose and why.
- confidence levels, limitations and uncertainties. (It is good practice to report both averages and ranges.)
- methodologies used to assess risks, including any key assumptions and judgements made.

Adaptation planning and implementation

As shown in Figure 2, the next steps in a process of risk assessment and adaptation planning involve prioritising and treating risks, and a continuous process of monitoring progress and adjusting interventions as required. However, these later steps, beyond the process of scenario analysis, are beyond the scope of this guide.

Adaptive management

Many of those undertaking climate scenario analysis will also need to engage in adaptive management. In other words, an ongoing and iterative approach to planning and decision-making that involves regularly assessing conditions and the effectiveness of interventions, weighing interventions against costs, and updating assessments and interventions based on new projections and data. Rather than a one-and-done approach, this is a dynamic, flexible process designed to cope with the inherent uncertainties of climate change and the complex and evolving nature of climate risks. Adaptive management involves setting flexible goals, implementing strategies that can be adjusted over time, and integrating ongoing monitoring and learning.

Key principles to consider when using climate scenarios in physical climate risk assessment

Prudent risk management

The impacts of climate change are widespread, rapid and accelerating. With every increment of warming, projected impacts and losses escalate (IPCC 2022). In many instances, the impacts of climate change are manifesting much faster than we expected 20 years ago. This is particularly concerning with respect to tipping points – thresholds which when crossed may trigger abrupt, non-linear and irreversible changes to our climate system.[1]

Prudent risk management demands that we take potential high-impact scenarios seriously as they can disrupt or even break our systems. By exploring extreme scenarios, users can identify vulnerabilities and critical areas for action.

The IPCC uses the concept of ‘low-likelihood, high-impact’ events to explore outcomes that, while there may only be a relatively low chance of them unfolding, would have severe and far-reaching consequences were they to do so, and therefore demand our attention. As explored elsewhere in this guide, it is vital that users consider not only the best possible future but the range of plausible climate futures, including worst case outcomes.

Compounding, cascading and systemic hazards

Individual climate hazards, such as extreme heat, heavy rainfall, elevated fire danger or prolonged drought do not act in isolation but can compound and exacerbate one another. With the growing frequency and severity of extreme weather events, communities and businesses may face repeated shocks with little time in between to recover. Increasingly, we are seeing rapid and extreme swings between opposing weather extremes, such as abrupt shifts from severe drought, heat and fire weather to intense rainfall and back again – a phenomenon known as climate whiplash or hydroclimate whiplash (Swain et al. 2025).

[1] When the IPCC first introduced the idea of tipping points in the Earth System over 2 decades ago, crossing them was only considered likely if warming exceeded 5 °C. Today, it is clear that abrupt and irreversible changes such the collapse of major ice sheets or the rapid decline of coral reefs could be triggered at much lower temperatures. Even at today’s level of warming, it is possible we have crossed tipping points for the Greenland ice sheet, West Antarctic ice sheet and coral reefs (Armstrong McKay et al. 2022).

Without efforts to adapt, businesses and communities may see their resilience progressively eroded by these compounding hazards. Climate scenario analysis should therefore consider how different types of hazards interact with one another. Indeed, climate scenarios are an important tool for exploring this added complexity.

Importantly, we need to understand not only the potential impacts of climate change upon our own assets and operations, but how climate change may affect the systems we are nested within. Thinking in systems helps to identify how changes in one system can flow onto others through compounding and cascading impacts. This amplifies the effects of individual hazards.

Acute and chronic hazards

In analysing current and future climate hazards it can be useful to divide them into acute and chronic hazards. Model averages provide insight into chronic hazards, whereas acute hazards are often missed. Examples are given in Table 4.

Acute climate hazards are those associated with the increased severity and/or frequency of extreme weather events. The effects are immediate, and can include direct physical damage, disruption of supply chains, threats to human safety, and substantial financial impacts for organisations and communities.

Chronic climate hazards are the long-term changes that unfold over years or decades, rather than sudden, short-term events. Effects accumulate gradually and, in the absence of risk assessment, may go unnoticed until they reach a critical level. Impacts can be deep and lasting, affecting multiple regions and sectors simultaneously.

Note that while this is a useful distinction, the line between acute and chronic hazards can often be blurred because they are interconnected and may amplify each other. For example, storm surges driven by more intense cyclones (an acute hazard) will be more destructive because they are riding upon higher sea levels (a chronic hazard).

Table 4: Acute and chronic climate hazards

Acute	Chronic
Cyclones that are more intense and dump greater rainfall.	**Sea-level rise**, threatening coastal infrastructure and communities.
Heat waves that are hotter, longer and more frequent.	**Shifting rainfall patterns**, leading to longer periods of drought.
Extreme downpours, leading to flooding.	**Increased temperatures,** causing expansion of disease vectors that enable tropical diseases to spread to new regions.
Highly destructive **bushfires.**	**Ocean acidification**, impacting marine biodiversity and productivity.

Longer-term changes

We tend to focus on relatively short-term changes to our climate system. However, some changes already in the system will continue to unfold over centuries and millennia, until our climate system reaches a new state of equilibrium. This is particularly important to keep in mind when assessing risks from sea-level rise. Even if we were to somehow reach net zero emissions tomorrow, sea levels will continue to rise for many centuries due to the vast amount of heat energy absorbed by the ocean and the continued melting of ice sheets.

Box 3: Considering sea-level rise in scenario analysis

Mean sea levels are rising around Australia and the globe, and more frequent extreme sea-level events are increasing the risk of inundation and damage to coastal infrastructure and communities.

Sea-level rise cause coastal flooding and can affect the patterns and extent of coastal erosion. Short-term impacts of coastal flooding include damage to infrastructure, pollution of groundwater systems by seawater, and road closures. Longer term impacts include more rapid degradation of infrastructure and associated economic losses, as well as coastal communities becoming untenable.

Sea levels around Australia will continue to rise beyond the end of this century. While the median sea-level rise projection of the National Climate Risk Assessment is 0.5 m by the end of this century, far higher increases over this period cannot be ruled out if polar ice sheets collapse.

Sea-level rise benchmarks for the end of the century set by most state and territory governments are ~0.8 – 1 m, well exceeding 0.5 m, and should strongly be considered for use in scenario analysis. Some projections (low confidence) find increases of 2 m by 2100 and 5 m by 2150 due to the possibility of an acceleration of the loss of ice from the Antarctic ice sheet.

	Snapshot	Current sea level rise planning benchmark
QLD	0.8 m by 2100	Sea-level rise factor of 0.8m by 2100.
NSW	No state sea-level rise benchmark	Determined by individual councils through a risk-based approach using scientific advice and understanding of local processes and impacts.
VIC	0.8 m by 2100	Plan for sea-level rise of not less than 0.8 m by 2100.
SA	1 m by 2100	Requires development to be safe from the effects of a 0.3 m sea-level rise by 2050 and to be capable of being protected against additional recession due to a further 0.7 m of rise by 2100 (total of 1 m by 2100).
TAS	0.82 – 0.92 m by 2100	North East Tasmania: 0.82 m by 2100 Central North Coast Tasmania: 0.92 m by 2100.
WA	0.9 m by 2110	Sea-level rise of 0.9 m over a 100-year planning timeframe (2010 to 2110). Add 0.01 m/year to 0.9 m for every year beyond 2110.
NT	0.8 m by 2100	Approximately 0.8 m by 2100.

Table 5: Australian sea level rise benchmarks for 2100.
Source: Modified from Intergovernmental Coastal Hazards Working Group (2023).

[Note: This table will be updated by the Coastal Hazards Working Group for the National Climate Scenario Guidance final document in early 2026.]

Risk adverse decision-makers may wish to use even greater values than the state and territory benchmarks, e.g. greater than 1 m.

It is important to realise that sea-level rise and global surface temperature respond to changes in climate forcing on very different timescales. While global surface temperatures can stabilise within decades after emissions are reduced, sea level will continue to rise into the future. This trend reflects the slow adjustment of the deep ocean and the long response times of the Antarctic and Greenland ice sheets, both of which keep evolving even after surface temperatures stop increasing. This delayed contribution is referred to as *committed* sea-level rise. Recent studies suggest that cumulative CO_2 emissions up to 2030 alone could commit the planet to around one metre of global mean sea-level rise by 2300.

Part 2: Developing your scenarios

2.1 Considerations

When developing scenarios, you should consider the following:

- your organisation's values and aspirations
- the purpose of the work for which the scenarios are needed
- the time and resources you have available
- the hazards that need to be considered
- your risk appetite
- the time horizons of decisions.

2.2 Checklist

Use this checklist as a guide to producing scenarios which follow best practice.

☐ **FIT FOR PURPOSE**
Does my analysis meet specific decision-making needs, such as providing the information needed for investment decisions?

☐ **COMPLIANT**
Have I met all statutory requirements and reporting standards?

☐ **COMPREHENSIVE**
Have I covered all relevant climate hazards and a suitable range of possible futures, including high-end risks and cascading, compounding and concurrent hazards?
For tips: see section 1.2 Emission pathways and 1.3 Other considerations when choosing and using climate scenarios

☐ **BEST PARAMETER CHOICES**
Am I using an appropriate future timeframe? Is it short/long enough considering the time and resources I have available?
For tips: see section 1.3 Other considerations when choosing and using climate scenarios

☐ **ACCESSIBLE**
Is my analysis simple and accessible enough for the intended users to understand?

☐ **TRANSPARENT**
Have I been clear and explicit about my assumptions and parameter choices?

2.3 Choosing pathways and timeframes

The following decision framework provides a simple guide and recommended choices for selecting emissions pathways and timeframes for a range of uses of climate scenario analysis.

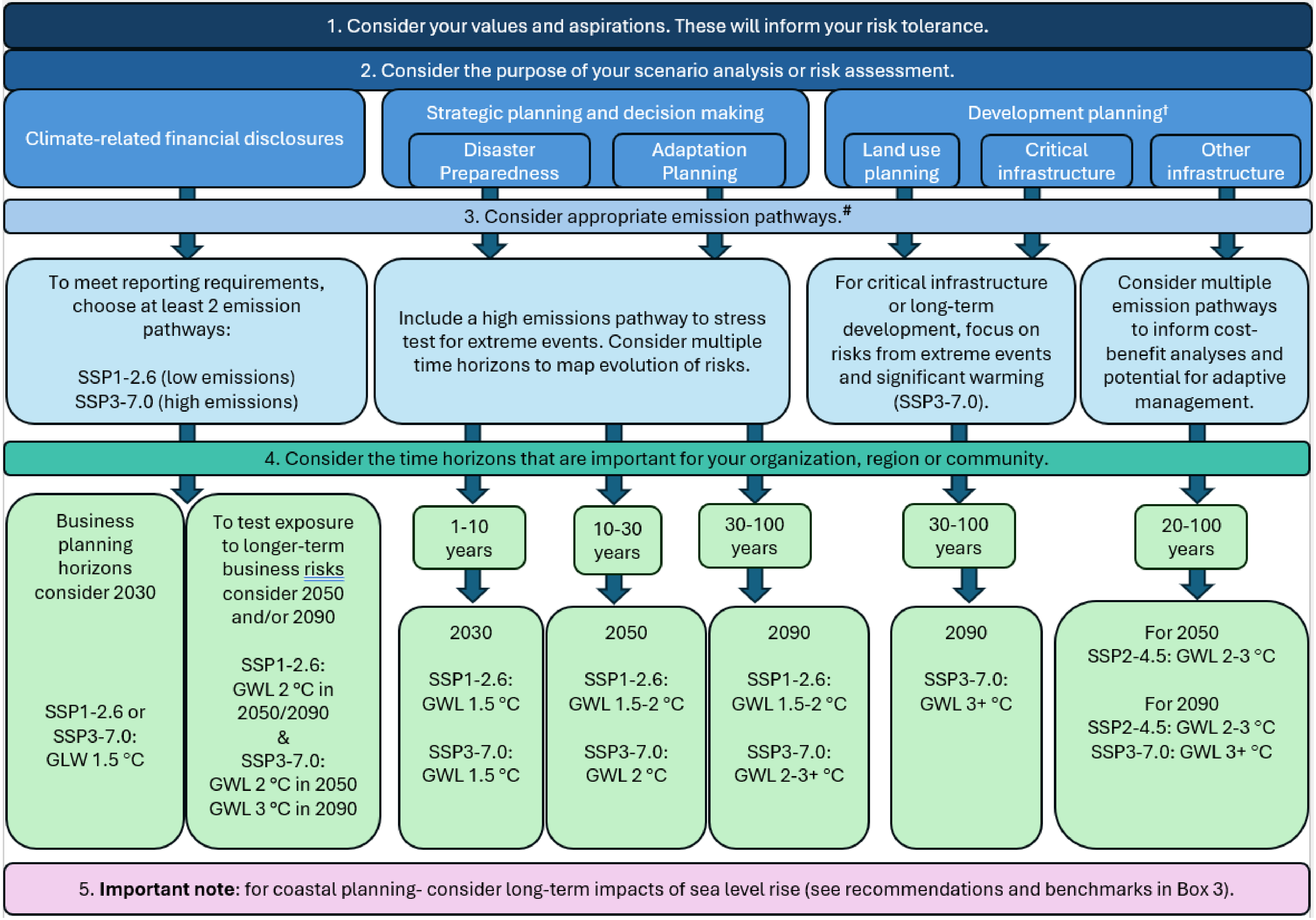
The best choice of emission pathway, global warming level, and time horizon depends on the specific goals and scope of your assessment and the question you are trying to answer. The new climate-related disclosure regime requires reporting entities to use at least 2 scenarios for global warming in their assessment. Strategic planning for disaster preparation or adaptation will typically also require consideration of multiple scenarios and multiple hazard types. Critical infrastructure and asset development, on the other hand, may require identifying a single number, such as a potential flood peak, usually with a higher level of risk aversion.

The recommended emissions pathways in the decision framework were chosen based on policy requirements and the likelihood that each pathway may eventuate (see Table 1). The best-available information indicates that the plausible range of future emission pathways is between the recommended low-emissions (SSP1-2.6) and recommended high-emissions (SSP3-7.0) pathways. SSP1-2.6 is aligned with the Paris Agreement goals, including in the best-case limiting the global temperature increase to 1.5 °C above pre-industrial levels. SSP2-4.5 (recommended medium-emissions pathway) is aligned with the current global policy pledges. SSP3-7.0 is a plausible high-emissions pathway recommended for stress-testing scenarios.

It is also important to consider drivers that are not fully represented in the SSP storylines such as tipping points or abrupt changes. A tipping point is a critical threshold beyond which a system reorganises, often abruptly and/or irreversibly (See Box 2). To explore the potential impacts of tipping points, experts recommend using a 'storyline' approach. This method links past, current and possible future events within a narrative framework, making it particularly useful for exploring how tipping points could affect businesses, organisations and communities.

Users should note that these are recommendations only, and you should consider your unique needs and circumstances, as well as applicable state or territory advice, when making these choices. In some cases, the best available data will use earlier generation emissions pathways (RCPs) rather than SSPs.

Once you have selected an emissions pathway/s and time frame/s, you can conduct your scenario analysis, using qualitative or quantitative information. See Part 1.4 for more information on conducting your scenario analysis


1. Consider your values and aspirations. These will inform your risk tolerance.
2. Consider the purpose of your scenario analysis or risk assessment.
Climate-related financial disclosures
Strategic planning and decision making
Disaster Preparedness
Adaptation Planning
Development planning†
Land use planning
Critical infrastructure
Other infrastructure
3. Consider appropriate emission pathways.#
To meet reporting requirements, choose at least 2 emission pathways:
SSP1-2.6 (low emissions)
SSP3-7.0 (high emissions)
Include a high emissions pathway to stress test for extreme events. Consider multiple time horizons to map evolution of risks.
For critical infrastructure or long-term development, focus on risks from extreme events and significant warming (SSP3-7.0).
Consider multiple emission pathways to inform cost-benefit analyses and potential for adaptive management.
4. Consider the time horizons that are important for your organization, region or community.
Business planning horizons consider 2030
SSP1-2.6 or SSP3-7.0: GLW 1.5 °C
To test exposure to longer-term business risks consider 2050 and/or 2090
SSP1-2.6: GWL 2 °C in 2050/2090
&
SSP3-7.0: GWL 2 °C in 2050 GWL 3 °C in 2090
1-10 years
2030
SSP1-2.6: GWL 1.5 °C
SSP3-7.0: GWL 1.5 °C
10-30 years
2050
SSP1-2.6: GWL 1.5-2 °C
SSP3-7.0: GWL 2 °C
30-100 years
2090
SSP1-2.6: GWL 1.5-2 °C
SSP3-7.0: GWL 2-3+ °C
30-100 years
2090
SSP3-7.0: GWL 3+ °C
20-100 years
For 2050
SSP2-4.5: GWL 2-3 °C
For 2090
SSP2-4.5: GWL 2-3 °C
SSP3-7.0: GWL 3+ °C
5. Important note: for coastal planning- consider long-term impacts of sea level rise (see recommendations and benchmarks in Box 3).

* The Corporations Act requires reporting entities to conduct, at a minimum, a scenario analysis for a temperature increase that 'well exceeds 2 °C' above pre-industrial levels, and one where the temperature increase is limited to 1.5 °C above pre-industrial levels. An increase of 2.5 °C would be considered to 'well exceed 2 °C'. The best estimate for warming under SSP3-7.0 is 3.6 °C by 2090. Warming of 1.5 °C is included within the 'very likely' temperature range for SSP1.2.6.
^ Critical infrastructure refers to the essential systems and assets vital to a nation's security, economy, public health, and safety. Examples include power grids, water supply systems, transportation networks, communication systems, and healthcare facilities.
†Land use planning must accord with the planning system in the state/territory.
While recommended emission pathways and time horizons are provided, users will have unique needs and circumstances that should be considered when making these choices.

2.4 Projections of future climate

There are different levels of information that can be used to support scenario analysis - from narrative descriptions of projected changes (for basic users or as a starting point for any analysis), to plausible ranges for key metrics (for intermediate users who want a bit more detail), through to outputs from climate projections models (for advanced users who need different variables, high resolution data or time series information for input into other models, such as economic models).

Starting with a narrative description of projected changes can help you quickly understand what future climate change may mean for the things you value.

Narrative descriptions of observed and projected changes are provided for 4 large climatic regions in section 2.4.1: Eastern [currently included], Northern [to be added], Central Rangelands [to be added] and Southern Australia [to be added]. The narratives describe projected climatic changes and resulting impacts for the period 2041-2060. Projected changes for the near-future (2021–2040) and longer-term future (2081–2100) are available in Appendix C.

As a first step in scenario analysis, average changes and impacts across a broad region will likely be useful. However, the wide geographic and climatic variability across Australia means that the average climatic conditions, won't reflect the range of conditions experienced within these 4 regions. Section 2.4.2 presents climate metrics for 8 natural resource management (NRM) clusters, subsets of the 4 larger regions, to better account for the variability throughout Australia.

2.4.1 Climate narratives

Figure 3: Map of Australia showing the 4 large climatic regions

Eastern Australia

[The past and future climate changes described here are currently based on an earlier generation dataset. The intention is for readers to see the type of information that will be provided, with the data and details to be updated in the final version of this guidance.]

Observed changes in recent decades

The last decade (2011-2020) has been the hottest on record, at around 1.5 °C above pre-industrial levels and XX °C higher than the 1990s. Extreme heat, such as the average number of days over 35 °C, has increased in virtually all towns and cities.

Heatwaves on land and in the ocean have become more frequent, longer, and more intense, leading to greater heat-related hazards for human and ecosystem health. The impact of drought has been exacerbated due to rising temperatures.

Extreme fire weather days have increased by approximately 15% in recent decades, with greater intensity. Individual extreme fire events have been exacerbated by climate change, with the Black Saturday event of 2019-2020 assessed to have been around 30% more likely than with the pre-industrial climate[2].

Extreme rainfall intensity has risen by about 7% (daily) and 10% (sub-daily) in recent decades, leading to greater risks such as flash-flooding, infrastructure and property damage, crop and livestock losses, supply chain disruption and water-borne disease. Extreme multi-day rainfalls, like those associated with the 2022 Lismore floods, may be more likely.

[2] van Oldenborgh et al (2021)

Sea levels have risen around 4mm per year between 1993 and 2019, causing more frequent coastal flooding, erosion and salt-water intrusion. Rising sea levels have impacted vulnerable coastal communities, settlements and people in low-lying areas in coastal regions of NSW.

East Coast Lows are occurring approximately 10% less often but are more damaging due to increased rainfall intensity, with more impact at the coast due to a higher sea level.

Projected changes in the medium-term future (2041 – 2060)

Eastern Australia is projected to become about 1.5 °C warmer than it was in the 1990s (and at least around 2.2 °C warmer than pre-industrial). Annual average rainfall could decrease a further 4% from the 1990s levels (range: -18% to +8%), with greater drying in winter and spring. The average number of days over 35 °C may increase by around 55% (range: 30-80%) in many towns and cities.

Heatwaves on land and in the ocean could become more frequent, longer, and more intense, causing more heat-related deaths, higher electricity demand, more blackouts, reduced labour productivity and declining ecosystem health. The impact of drought may be exacerbated due to rising temperatures, leading to water shortages, crop losses and increased stress in rural areas.

Extreme fire weather days could increase by about 30% with greater intensity, as well as a longer fire season, causing more deaths and injuries, infrastructure and property damage, and poor air and water quality.

Despite reduced annual average rainfall, extreme daily rainfall intensity could rise by about 15%, leading to greater flood risk, infrastructure and property damage, crop and livestock losses, supply chain disruption, and water-borne disease.

Average sea level may rise by around 25 cm, causing more frequent coastal flooding, erosion, and salt-water intrusion. East Coast Lows could occur about 20% less often but may be more damaging due to increased rainfall intensity and a higher sea level.

Northern Australia

Observed changes in recent decades

[To be provided in the final version]

Projected changes in the medium-term future (2041 – 2060)

[To be provided in the final version]

Central Rangelands

Observed changes in recent decades

[To be provided in the final version]

Projected changes in the medium-term future (2041 – 2060)

[To be provided in the final version]

Southern Australia

Observed changes in recent decades

[To be provided in the final version]

Projected changes in the medium-term future (2041 – 2060)

[To be provided in the final version]

Additional information

If you want to develop or access more regionally specific scenarios, you can explore the Climate Change in Australia portal or the Australian Climate Service's data explorer. State and territory governments, in collaboration with universities and science agencies, have also built climate information platforms delivering scenarios and guidance. See the NESP climate portals infographic [4.7 MB] or Table 6 in Part 3 for more details. Some include the NSW Climate Data Portal, Queensland Future Climate, South Australian climate projections viewer and Victoria's Future Climate Tool.

If you want to see an example of climate information portals being used, see the stress testing for the potential impact of heatwave on Ambulance Victoria case study. It provides a snapshot of the models and methods they used to better understand the effect of the projected increased frequency and severity of heatwaves on their strategic objectives. AdaptNSW features a range of NSW and Australian Regional Climate Modelling (NARCliM) case studies that demonstrate how NARCliM climate data is being applied across various sectors.

2.4.2 Climate metrics

This section provides plausible ranges for key climate variables for 8 natural resource management (NRM) clusters (Figure 4). The NRM regions were developed by logical groupings of recent past climatic conditions, biophysical factors and expected broad patterns of climate change.

These tables may not include all the climate information relevant to all potential users. For instance, some users may require sector-specific variables or information at finer spatial scale. Further information on sourcing appropriate climate information is available in the NESP guide on finding and selecting the right climate change information [PDF 4.7 MB] for more details. For detailed high-resolution climate information, follow the links to datasets in Part 3.

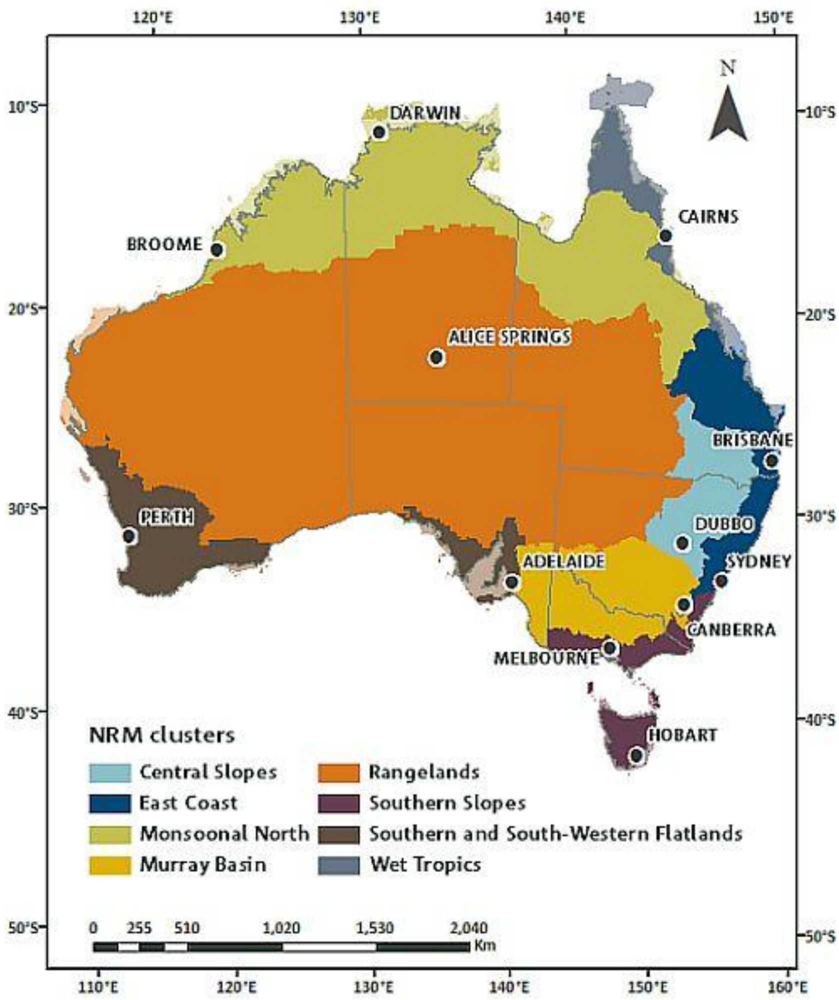


Figure 4: Eight natural resource management (NRM) clusters of Australia.

Central slopes (NSW, Qld)

[*Table 6 shows the format and information that will be provided for each of the 8 NRM clusters in the final version. It is currently not populated.*]

Table 6: Key climate variables for SSP1-2.6 (low emissions) and SSP3-7.0 (high emissions) scenarios

Average temperature and extreme heat events

	Current	2030	2050	2050	2090	2090
Emission pathway	(GWL 1.2 °C)	(GWL 1.5 °C)	**SSP1-2.6** (GWL 1.5-2 °C)	**SSP3-7.0** (GWL 2 °C)	**SSP1-2.6** (GWL 1.5-2 °C)	**SSP3-7.0** (GWL 3-4 °C)
Average annual temperature	x °C	x °C	x °C	x °C	x °C	x °C
Average annual mean temp (°C)	[y, z]	[y, z]	[y, z]	[y, z]	[y, z]	[y, z]

Annual days >35°C	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]
Annual days >40°C	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]

Average rainfall, extreme rainfall and riverine floods

	Current	2030	2050	2050	2090	2090
Emission pathway	(GWL 1.2 °C)	(GWL 1.5 °C)	**SSP1-2.6** (GWL 1.5-2 °C)	**SSP3-7.0** (GWL 2 °C)	**SSP1-2.6** (GWL 1.5-2 °C)	**SSP3-7.0** (GWL 3-4 °C)
April to October seasonal rainfall Seasonal rainfall (mm)	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]
November to March seasonal rainfall Seasonal rainfall (mm)	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]
Extreme rainfall Highest 1-hour rainfall total	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]
Extreme rainfall Highest 1-day rainfall total	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]	x mm [y, z]

Drought

	Current	2030	2050	2050	2090	2090
Emission pathway	(GWL 1.2 °C)	(GWL 1.5 °C)	**SSP1-2.6** (GWL 1.5-2 °C)	**SSP3-7.0** (GWL 2 °C)	**SSP1-2.6** (GWL 1.5-2 °C)	**SSP3-7.0** (GWL 3-4 °C)
Time spent in drought Percentage of time in drought compared to a reference period	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]

Extreme bushfire events

Emission pathway	Current (GWL 1.2 °C)	2030 (GWL 1.5 °C)	2050 (GWL 2 °C)	2090 (GWL 3-4 °C)
Fire susceptibility Qualitative info				

Extratropical lows

Emission pathway	Current (GWL 1.2 °C)	2030 (GWL 1.5 °C)	2050 SSP1-2.6 (GWL 1.5-2 °C)	2050 SSP3-7.0 (GWL 2 °C)	2090 SSP1-2.6 (GWL 1.5-2 °C)	2090 SSP3-7.0 (GWL 3-4 °C)
Frequency of extratropical lows Time influenced by an extratropical low (hours per year)	x hours [y, z]	x hours [y, z]	x hours [y, z]	x hours [y, z]	x hours [y, z]	x hours [y, z]

Sea-level rise and extreme sea-level rise events

Emission pathway	Current (GWL 1.2 °C)	2030 (GWL 1.5 °C)	2050 SSP1-2.6 (GWL 1.5-2 °C)	2050 SSP3-7.0 (GWL 2 °C)	2090 SSP1-2.6 (GWL 1.5-2 °C)	2090 SSP3-7.0 (GWL 3-4 °C)
Sea-level rise Mean sea-level rise (m)	x m [y, z]	x m [y, z]	x m [y, z]	x m [y, z]	x m [y, z]	x m [y, z]
Frequency of coastal flood days Days per year	x days [y, z]			x days [y, z]		x days [y, z]

Oceans

Emission pathway	Current (GWL 1.2 °C)	2030 (GWL 1.5 °C)	2050 (GWL 2 °C)	2090 (GWL 3-4 °C)
Marine heatwave frequency Annual average number of marine heatwaves	x days [y, z]	x days [y, z]	x days [y, z]	x days [y, z]

East coast (NSW, Qld)

[These tables will be provided in the final version]

Monsoonal north **(Qld, NT, WA)**

[These tables will be provided in the final version]

Murray Basin **(NSW, Vic, SA)**

[These tables will be provided in the final version]

Rangelands **(NSW, Qld, NT, WA, SA)**

[These tables will be provided in the final version]

Southern slopes **(NSW, WA, Tas)**

[These tables will be provided in the final version]

Southern and south-western flatlands **(WA, SA)**

[These tables will be provided in the final version]

Wet tropics **(Qld)**

[These tables will be provided in the final version]

Part 3: Australian climate projections datasets

The numerous sources of climate change data in Australia vary in presentation, coverage, scale, and time periods. For guidance on selecting the appropriate information for your needs and links to the available portals, see the NESP Navigating climate portals guide [PDF 841 KB].

Physics-based climate modelling is a central tool for understanding our climate system and making projections of the future climate under different scenarios of societal development. The climate system involves global interactions between the atmosphere, oceans, land surface and sea ice, and is represented by global climate models (GCMs) that use mathematical expressions to represent processes in the Earth's climate (Figure 5).

The latest international-standard global modelling is currently from the 6th phase of the global Coupled Model Intercomparison Project (CMIP6). CMIP6 GCMs provide data at ~100 km resolution, including from the Australian Community Climate and Earth System Simulator (ACCESS).[3]

CMIP6 climate projections supplement previous projections (CMIP5 and earlier). They do not contradict or replace them, but provide additional insight based on new climate modelling. Projections are produced for updated sets of global scenarios that are periodically updated e.g. from the Representative Concentration Pathways (RCPs) to the Shared Socioeconomic Pathways (SSPs), and these differences mean projections are not precisely comparable – but at least the consistency of general findings and conclusions can be examined (see Appendix A for RCP and SSP comparisons).

Climate data sources can represent reasonable future scenarios using different methods and assumptions. Each source has strengths suited to various applications, and even older models remain valuable for understanding climate scenarios.

3.1 Regional and local climate information

The process of translating the coarse-resolution outputs from GCMs into more localised, higher resolution climate information is known as downscaling. This can be done in multiple ways.

Dynamical downscaling takes results from a GCM and puts them into a regional climate model (RCM) which then runs simulations over a smaller area and at a higher resolution (~10–20 km resolution) (see explanation of RCMs in Part 1.2 and more detail in Figure 5). Even higher resolution information can be obtained with convection-permitting modelling (see Box 4). This approach can provide realistic simulations of local climate processes but requires large amounts of computing power.

Alternative and less resource-intensive approaches rely on statistical techniques rather than computer simulations. For example, change factor methods combine the outputs from GCMs with local historical weather observations to create localised projections. While widely used and accepted

[3] ACCESS is a state-of-the-art climate and Earth system modelling capability developed collaboratively by the Bureau of Meteorology and CSIRO, with input from universities and international partners. ACCESS is used for operational forecasting, climate research, and contributing to international assessments, including the Intergovernmental Panel on Climate Change (IPCC).

in climate impact studies, they have some disadvantages compared to dynamical downscaling. For example, they may not accurately represent changes in regions with complex topography and, in their basic form, may only provide average changes rather than ranges or extremes.[4] However, they can be less affected by model biases than direct (uncalibrated) outputs of dynamical downscaling.

RCMs add value to GCMs at the regional scale by improving the representation of local topography and small-scale atmospheric processes. However, it is important to still consider the big-picture view of the system and analyse the GCMs used to derive the RCMs. Caution is required in interpreting the 'added value' of RCMs as the models cannot overcome problems related to GCMs, such as uncertainty with GCM inputs. Thus, we recommend comparing fine (RCMs) and coarse (GCMs) resolution information for the same location.

3.2 Application-ready data

Due to known systematic biases in climate models compared to the real world, raw model outputs (both GCM and RCM) should be calibrated to the observed datasets used for climate analyses – that is, made 'application-ready'. Following adjustment and calibration to observations these data are more suitable for use in applications such as agricultural or economic models. Multiple organisations have produced application-ready, high-resolution regional climate projection information for Australia (Figure 5). The types of outputs, climate variables, time frames, emission pathways, and baselines for each portal are detailed in the NESP Navigating climate portals guide [PDF841 KB]. Advanced users might require time series data for economic modelling or other downstream applied modelling that hasn't already been produced. In those cases, we recommend obtaining the application-ready datasets from the portals linked in Figure 5.

There are various methods to produce application-ready locally relevant datasets. The 2 main categories of using model outputs are: (1) scaling of observations using 'change factors' taken from models, and (2) calibrating a model output to an observed dataset known as bias adjustment (where 'bias' refers to a difference between the model and the observed dataset).

3.3 Sensible use of climate projections

Climate projections are not predictions, so they should always be used with cation and considered in the context of estimated change in the climate due to human influence.

Climate risk assessments should account for the confidence of each projected change based on multiple lines of evidence – such as observations, model evaluation and model agreement. For example, climate models provide extremely high confidence that temperatures across Australia will increase, but lower confidence in projected rainfall patterns. See the ranges given for projections in the metric tables in Part 2.5.

Climate models represent uncertain futures. The consideration of multiple models is recommended to gauge the range of plausible possibilities of the future.

Box 4: Convection-permitting versus traditional climate models

[4] CSIRO has developed downscaled datasets using a 'quantile delta change method'. This is more sophisticated and realistic than a basic change factor method as it preserves the full range of projected outcomes, including extremes, not just the averages (Irving and Macadam 2024).

Convection is the vertical movement of air in the atmosphere caused by differences in temperature and density. It is fundamental to the formation of clouds, precipitation and storms. However, the process happens at a scale too small to be directly simulated by traditional climate models, which instead use mathematical techniques known as parameterisations to estimate the average impact of convective events.

A convection-permitting model operates at a sufficiently high spatial resolution – typically with a grid spacing of less than 4 km – to directly simulate convection and the formation of thunderstorms, intense rainstorms, localised extreme wind, and other high-impact phenomena. These modern, high-resolution models also better represent surface features, such as cities, coastlines and mountains, enabling more accurate simulations of local climate. Convection permitting models offer more detailed and potentially more reliable projections, particularly when it comes to the extreme events that cause the greatest impact.

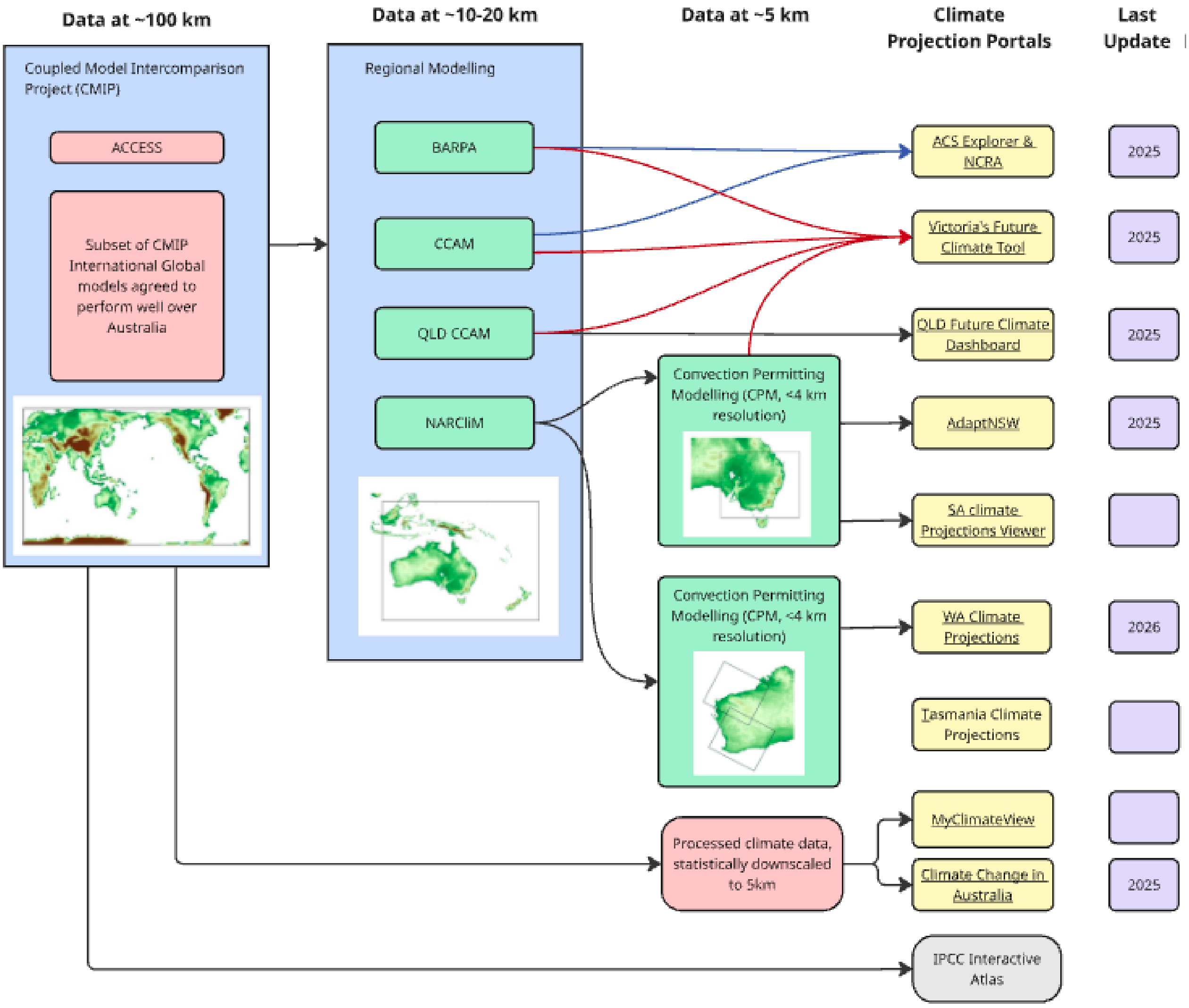


Figure 5: Where does Australia's climate data come from? The flow of information from the Global Climate Models, with data at ~100 km resolution to downscaled regional modelling at 10-20 km resolution, to high-resolution models at ~5 km resolution from convective permitting modelling (see Box 4) or statistically downscaled data. [*Links will be provided to the portals in the final version.*]

3.4 Which dataset(s) to choose

If possible, use all the datasets available, then compare and use the outputs. However, if some sub-selection needs to be done, then consider:

1) the guidelines or standards in the jurisdiction or program you are working within
2) the level of data and information needed to achieve the goal – from summary statements, qualitative information, summary statistics, summary indices, through to accessing datasets at the end of the chain
3) establishing the context/s of interest – the relevant time horizons, SSPs, GWLs
4) viewing and orienting yourself with projections via technical reports or a viewer tool to have a sense of the relevant projections
5) the variables, indices and downstream modelling that are required
6) the index or model you will use the projections for - what it requires and how it will work with projections data.

If you are working for a state/territory government, you should follow their guidelines.

Appendices

Appendix A: Emissions pathways in detail

Figure 6 provides a guide to the timing of reaching different global warming levels for SSP1-2.6 (low emissions) and SSP3-7.0 (high emissions). Due to past emissions all SSPs reach 1.5 °C in the 2030s and then diverge. SSP1-2.6 reaches 2 °C around 2050 and then stabilises. SSP3-7.0 reaches 2 °C around 2050, 3 °C around 2070 and then 4 °C by 2100.

A horizontal line marks the current global temperature increase at approximately 1.2°C. Additional lines highlight the 1.5 °C and 2 °C warming thresholds. The graph emphasises the divergence in future warming based on emissions pathways and underscores the importance of mitigation efforts.

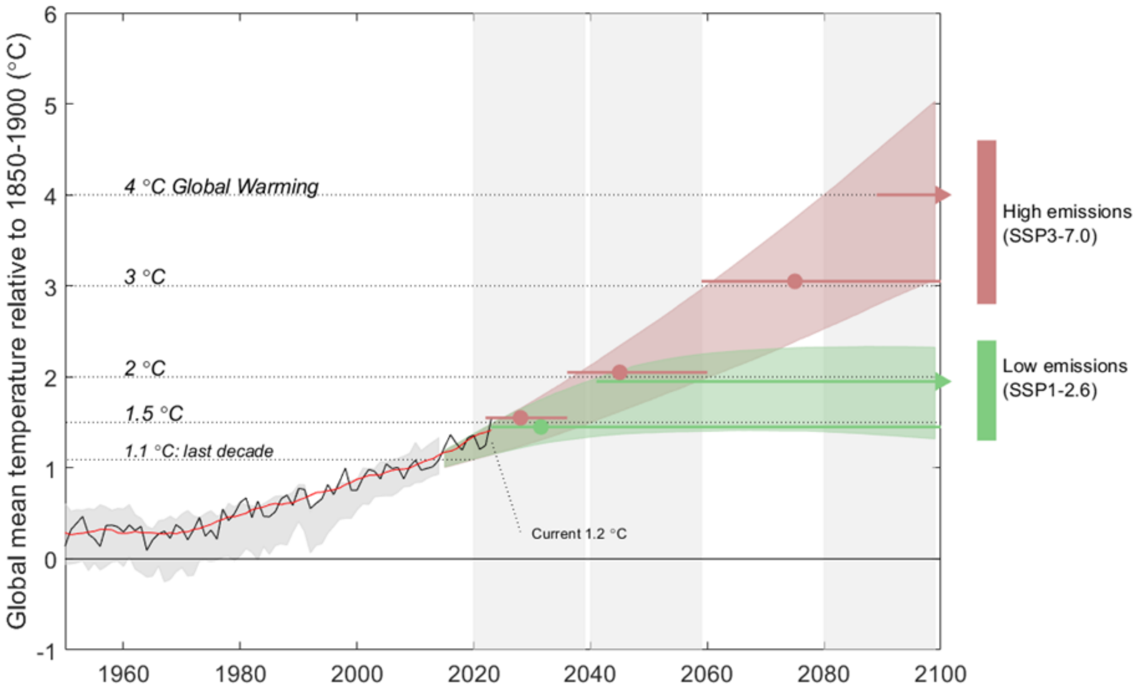


Figure 6: The estimated timing of global warming levels being reached under different emissions pathways. The graph shows observed global temperatures (in grey) and future modelled global temperature under a low emissions pathway (SSP1-2.6, green) and a high emissions pathway (SSP3-7.0, red). Temperatures are shown relative to 1850–1900. Red and green horizontal lines show the time window (and central estimate) of when each global warming level (1.5 °C, 2 °C, 3 °C and 4 °C) is reached under each scenario. The green and red vertical bars at the right-hand side of the plot show the projected global warming range by the end of the century under each scenario. Source: Round *et al.* 2024.

Table 7: Additional detail on SSPs, including notes on appropriate usage.
Adapted from NESP's explainer What are SSPs? [PDF 185 KB]

	SSP1-1.9 SUSTAINABILITY (very low emissions)	**SSP1-2.6** SUSTAINABILITY (low emissions)	**SSP2-4.5** MIDDLE OF THE ROAD (intermediate emissions)	**SSP3-7.0** REGIONAL RIVALRY (high emissions)	**SSP5-8.5** FOSSIL-FUELLED DEVELOPMENT (very high emissions)
RCP equivalent	No equivalent RCP	RCP2.6	RCP4.5	No equivalent RCP	RCP8.5
Emissions reduction	Very steep and immediate	Steep and immediate	Moderate from 2040s	None (minor slowing)	None (accelerating)
Energy sources	Renewables	Renewables and biofuels	Renewables and fossil fuels	Fossil fuels	Increased fossil fuel use
Carbon dioxide removal	Assumes very large quantities of CO_2 removed from the atmosphere, requiring new technologies.	Assumes CO_2 removed from the atmosphere, requiring new technologies.	None	None	None
Global socio-economic trends	Inclusive development, reduced inequality, and strong environmental stewardship; increasing action towards Sustainable Development Goals (SDGs).	Inclusive development, reduced inequality, and strong environmental stewardship; increasing action towards SDGs.	A continuation of current trends, with moderate and unevenly distributed progress on sustainability and human development; slow progress towards SDGs.	Fragmented and unequal development; weak international cooperation.	Rapid economic growth and technological advancement powered by fossil fuels; resource intensive lifestyles and industries; high investment in health and education.
GWL by 2050* (2041-2060)	1.6 °C [1.2–2.0 °C]	1.7 °C [1.3–2.2 °C]	2.0 °C [1.6–2.5 °C]	2.1 °C [1.7–2.6 °C]	2.4 °C [1.9–3.0 °C]
GWL by 2090 (2081-2100)	**1.4°C** [1.0–1.8 °C]	**1.8°C** [1.3–2.4 °C]	**2.7°C** [2.1–3.5 °C]	**3.6°C** [2.8–4.6 °C]	**4.4°C** [3.3–5.7 °C]
Rule of thumb Due to past emissions, all SSPs reach 1.5 °C in the 2030s and then diverge	Overshoots 1.5 °C slightly around 2050 then returns and stabilises near 1.5 °C by 2100.	Reaches 2 °C around 2050s and stabilises.	Reaches 2 °C around 2050s and 2.7 °C by 2090.	Reaches 2 °C around 2050s, 3 °C around 2070s, and 4 °C possible by 2090.	Reaches 2 °C around 2050s, 3 °C around 2060s, and 4 °C around 2080s.
Notes on usage	A very stringent pathway that supports the goal limiting warming to 1.5 °C. There is limited downscaled data available for assessing impacts under SSP1-1.9.	This is our lowest recommended scenario for the purposes of assessing physical risks. Warming of 1.5 °C is included within the 'very likely' temperature range for SSP1.2.6, meaning this scenario should satisfy the requirement under the Corporations Act to use a scenario that sees the global average temperature limited to 1.5 °C.	This intermediate scenario most closely resembles the current global emissions trajectory (CAT). While this may satisfy the formal requirement under the Corporations Act to use a scenario that sees the global average temperature 'well exceeds 2 °C', we recommend users also consider a higher warming scenario, in order to more fully account for potential future risks.	This is our recommended choice for a high-risk scenario for use in climate scenario analysis and risk assessments. Current best estimates of likely warming this century do not project global warming as high as 4 °C. However, given the inherent uncertainty in climate projections and the possibility that warming could well exceed our current best estimates, prudent risk management demands that we also consider such scenarios.	Originally designed as a worst case scenario. SSP5-8.5 is now considered an unlikely scenario due to recent shifts in global energy trends. As with SSP1-1.9, there is limited downscaled data available for assessing impacts under SSP5-8.6. There are cases where considering the very high levels of warming reached in SSP5-8.5 are appropriate, such as for sea-level rise or other decisions that may want to consider the impact of tipping points unaccounted for in projections. To assess high-end risks, we suggest using the upper

end of the range of outcomes from SSP3-7.0.

*The IPCC uses 20-year averages to assess climate change. Projected future changes are calculated for the current-to-near-term (2021–2040), medium-term (2041–2060), and long-term (2081–2100). For simplicity, these may be expressed as 2030, 2050 and 2090 – the midpoints of these periods. In some instances, projections are also provided for the 'extended long-term' (2101–2300), to further explore phenomena including sea-level rise and tipping points.
^Very likely means a probability of >90%. In other words, it is 90% likely that the temperature outcome will fall within this range.

Additional notes on Table 7

Understanding SSP (Shared Socioeconomic Pathway) nomenclature

SSP1-2.6

First number (1) = Global socioeconomic narrative.

1 – Sustainability
2 – Middle of the road
3 – Regional rivalry
4 – Inequality
5 – Fossil-fuelled development

Full descriptions of the SSPs can be found in the IPCC Sixth Assessment Report (Working Group 1), pages 232-236.

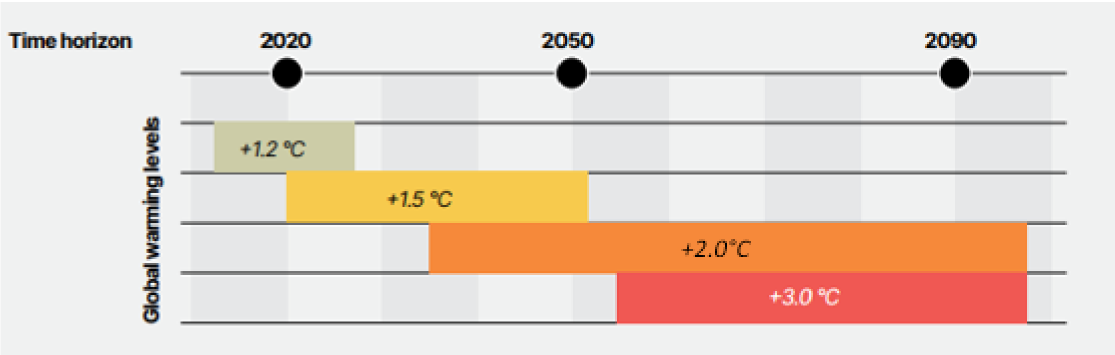
Second number (2.6) = Extra greenhouse effect at 2100, measured in watts per square metre.

Appendix B: Commonwealth initiatives

[This section is intended to include information on how this guidance fits with other commonwealth initiatives. In the final guidance we fill out this appendix to provide additional information for the Climate Risk and Opportunity Management Program (CROMP), the Australian Sustainability Reporting Standard AASB S2 Climate-Related Disclosures, and other relevant initiatives.]

National Climate Risk Assessment (NCRA)

The National Climate Risk Assessment (NCRA) is the first comprehensive analysis by Government of the climate risks and impacts Australia may face under future climate scenarios (+1.5 °C, +2 °C and +3 °C). It has been developed by the Australian Climate Service, which is a partnership between the Bureau of Meteorology, CSIRO, the Australian Bureau of Statistics, and Geoscience Australia, using the best available climate, hazard, geospatial and sectoral data.



The NCRA was developed through a rigorous, two-stage process to build a shared understanding of Australia's most significant climate risks.

- The first pass assessment identified 56 nationally significant risks Australia is facing due to climate change.
- From this, a subset of 11 priority risks were selected for deeper analysis in the second pass assessment, using both qualitative and quantitative methods.

Key resources have been developed to provide a national picture of climate risk including:

- an Overview of the National Climate Risk Assessment
- the full National Climate Risk Assessment
- a comprehensive body of technical reports.

The NCRA provides tailored climate data for the Australian context to support local understanding and unpack the climate risks facing Australia now and into the future.

Appendix C: Climate narratives for projected changes at 2030 and 2090

This appendix provides an additional 2 narratives of projected changes for 4 large regions of Australia that are provided in Section 2.4.1. The 2 projected changes are:

1. Near-future (2021–2040) – these impacts are already 'baked in' to the system, with a global average temperature increase of 1.2-1.8 °C relative to 1850–1900.

2. Longer-term future (2081–2100) – Projections for SSP3-7.0, GWL2-3+ °C will be included. Projections for SSP1-2.6 in 2090 closely resemble those for the medium term (2041–2060), refer to the medium-term narratives in Section 2.4.1 when assessing SSP1-2.6 at 2090.

Eastern Australia

Projected changes in the near-future (2021–2040)

[To be provided in the final version]

Projected changes in the longer-term future (2081 – 2100)

Eastern Australia could be almost 3.5 °C warmer than it was in the 1990s and almost 10% drier (uncertainty range -22 to +15%). The average number of days over 35 °C may increase by about 200% (uncertainty range 100-300%) in many towns and cities.

Heatwaves on land and in the ocean could become much more frequent, longer, and more intense, causing more heat-related deaths, higher electricity demand, more blackouts, reduced labour productivity and declining ecosystem health. Droughts may be more frequent and more intense, leading to significant water shortages, crop losses and major stress in rural areas.

Extreme fire weather days could increase by about 60% and be far more intense, causing a huge increase in deaths and injuries, infrastructure and property damage, and poor air and water quality.

Extreme daily rainfall intensity may rise by almost 30% leading to much greater flood risks, infrastructure and property damage, crop and livestock losses, supply chain disruption, and water-borne disease.

Average sea level could rise by around 65 cm, causing far more frequent coastal flooding, erosion, and salt-water intrusion. East Coast Lows may occur about 40% less often but be more damaging due to increased rainfall intensity.

Northern Australia

Projected changes in the near-future (2021–2040)

[To be provided in the final version]

Projected changes in the longer-term future (2081 – 2100)

[To be provided in the final version]

Central Rangelands

Projected changes in the near-future (2021–2040)

[To be provided in the final version]

Projected changes in the longer-term future (2081 – 2100)

[To be provided in the final version]

Southern Australia

Projected changes in the near-future (2021–2040)

[To be provided in the final version]

Projected changes in the longer-term future (2081 – 2100)

[To be provided in the final version]

Appendix D: Development of this guidance

[Include a brief section on the consultation process, including delivery of a survey and industry-focused workshop in partnership with Standards Australia: Insights Report: National Climate Scenario Guidance Stakeholder Consultations [PDF 3.12 MB] as well as a brief description of what we heard during the 'Have your say' consultation process.]

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